CLAIMS

1. A process for making a fluorine-free plasma cured material comprising:

providing a porous dielectric material having a first dielectric constant, having a first elastic modulus, and having a first material hardness; and

plasma curing the porous dielectric material with a fluorine-free plasma gas to produce a fluorine-free plasma cured porous dielectric material having a second dielectric constant which is less than or about equal to the first dielectric constant, having a second elastic modulus which is greater than the first elastic modulus, and having a second material hardness which is greater than the first material hardness, wherein the fluorine-free plasma gas comprises a combination of CH_4 plasma gas and N_2 plasma gas.

2. The process of claim 1 wherein the porous dielectric material is selected from an organic dielectric material, an inorganic dielectric material, or a combination thereof.

3. The process of claim 2 wherein the organic dielectric material is selected from a hydrogen silsesquioxane dielectric material, a methylsilsesquioxane dielectric material, or a combination thereof.

4. The process of claim 1 wherein the porous dielectric material is produced by

depositing a dielectric coating on a substrate using a spin-on process or a chemical vapor deposition process, and

forming pores in the coating.

5. The process of claim 1 wherein the porous dielectric material is selected from a porogen-generated porous dielectric material, a solvent-formed porous dielectric material, a molecular engineered porous dielectric material, or a combination thereof.

6. The process of claim 1 wherein the porous dielectric material is plasma cured at a temperature less than or about 450°C.

7. The process of claim 1 wherein the porous dielectric material is plasma cured at a temperature between about 250°C and about 450°C.

8. The process of claim 1 wherein the porous dielectric material is plasma cured at a process pressure between about 1.0 Torr and about 5.0 Torr.

9. The process of claim 1 wherein the porous dielectric material is plasma cured for a time less than or about 180 seconds.

10. The process of claim 1 wherein the fluorine-free plasma gas further comprises H_2 plasma gas.

11. The process of claim 1 wherein the fluorine-free plasma gas further comprises a noble gas.

12. The process of claim 11 wherein the noble gas is selected from He, Ar, Ne, or combinations thereof.

13. The process of claim 1 wherein the fluorine-free plasma gas defines a gas ratio of CH_4 to N_2, and wherein the gas ratio is about 0.01 to about 0.05.

14. The process of claim 1 wherein the increase in elastic modulus between the first elastic modulus of the porous dielectric material and the second elastic modulus of the fluorine-free plasma cured porous dielectric material is greater than or about 50%.

15. The process of claim 1 wherein the increase in elastic modulus between the first elastic modulus of the porous dielectric material and the second elastic modulus of the fluorine-free plasma cured porous dielectric material is greater than or about 100%.

16. The process of claim 1 wherein the second elastic modulus of the fluorine-free plasma cured porous dielectric material is greater than or about 3 GPa.

17. The process of claim 1 wherein the second elastic modulus of the fluorine-free plasma cured porous dielectric material is between about 3 GPa and about 10 GPa.

18. The process of claim 1 wherein the increase in material hardness between the first material hardness of the porous dielectric material and the second material hardness of the fluorine-free plasma cured porous dielectric material is greater than or about 50%.

19. The process of claim 1 wherein the second material hardness of the fluorine-free plasma cured porous dielectric material is greater than or about 0.3 GPa.

20. The process of claim 1 wherein the second material hardness of the fluorine-free plasma cured porous dielectric material is between about 0.5 GPa and about 1.0 GPa.

21. The process of claim 1 wherein a level of outgassing of the fluorine-free plasma cured porous dielectric material is significantly reduced or eliminated as compared to a thermal cured porous dielectric material.

22. A fluorine-free plasma cured porous dielectric material prepared by the process of claim 1.

23. An electronic device containing a fluorine-free plasma cured porous dielectric material prepared by the process of claim 1.

24. A substrate having a fluorine-free plasma cured coating prepared by the process of claim 1.

25. A fluorine-free plasma cured porous dielectric material having a dielectric constant between about 1.1 and about 2.7 and an elastic modulus between about 3 GPa and about 10 GPa.

26. A fluorine-free plasma cured porous dielectric material having a dielectric constant between about 1.5 and about 2.3 and an elastic modulus between about 3 GPa and about 10 GPa.